John W. S. Leiper.

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Helminthology in its Application to Live-stock

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Helminthology in its Application to Live-stock.*

By Thomas W. M. Cameron, M.A., D.Sc., M.R.C.V.S.

The helminths of the domesticated animals are very closely related to those of man ; so much so, that no student of the one branch can afford to neglect the study of the other. In practice however, several very important distinctions must be drawn between these two groups. In the first place, human helminths are essentially tropical in their importance : veterinary helminths, on the other hand, are nearly as important in temperate as in tropical climates. Secondly, hygiene and sanitary science have practically eliminated human helminths from temperate countries ; these sciences have scarcely touched the domesticated animals yet and the parasitic worms continue to be highly important factors in animal health. By its very nature, veterinary helminthology is much more difficult and much more complicated than is human helminthology. Animals normally live in an environment more than favourable for parasites : they continually contaminate their food with droppings ; their food is uncooked and their skins are hairy and dirty.

Far from improving, the situation in animals is steadily becoming worse. As agricultural science makes possible the keeping of more and still more animals on a limited area, so also does it make possible an increase in numbers of their parasitic worms. There has been a gradual transition from nomadic conditions on open fields and hills to enclosed fenced conditions in farm-steads. Under natural conditions, ground is normally lightly stocked with scrub animals. In artificial modern conditions, land is heavily stocked with pure bred animals with a high productive capacity and a low resistance to disease. And this country now supports a million horses, seven and a half million cattle, over

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26 million sheep and nearly three and a half million pigs. Egg production in the parasite has been evolved to provide against light stocking—for sheep in the hills and horses in the dry plains. The chances of individual re-infection were slight—about one in a million—and so Ascaris learned to produce some 30,000 eggs daily and Tænia 150 millions yearly so that even one might return to continue the race. We have confined the range of our animals, the eggs have been concentrated and parasitic infection has become so heavy as to produce disease. It must not be thought that the parasites are harmful naturally. A large proportion of such pathological lesions as do occur are due to larval forms. No adult worm desires to injure its host and so sacrifice its own life. It is only when through accident, that numbers increase beyond the supporting capacity of the host, that disease commences. Practically all wild animals carry worms ; few suffer from worm-produced disease. That is a penalty we pay for our disturbance of the balance of nature.

It is difficult to estimate just what this disturbance is costing us. Sheep and horses suffer more from parasitic disease than from any other cause ; pigs and carnivores nearly as much. We know that Liver Fluke costs this country at least a million pounds yearly ; even more costly are the losses due to the small intestinal trichostrongyles, to hook-worms and to lung-worms in sheep. Probably we shall not be far from the mark if we estimate that about 10 per cent. of all sheep (especially lambs) die yearly from worms—directly or indirectly. The percentage is even higher in horses and pigs. The losses are not confined to death however ; condemnation of food offal in the meat market, lowered production of meat, milk, eggs, power, young and growth are even more important. They are generally attributed to other causes because the common symptoms of helminthiasis—a prolonged and progressive afebrile unthriftiness gradually resulting in death—are not sufficiently spectacular to attract attention or are masked by superimposed bacterial infections. We are certainly under-estimating the situation if we say that over ten million pounds are lost to this country yearly through the agency of helminths. This estimate is based on the present low price of stock.

We know that some of this loss is already preventable, and we are reasonably certain that much more could be if we had fuller information about the various species infecting animals. About a thousand species are already known to parasitise domesticated animals in various parts

of the world. We know none of them thoroughly—not even well—and most of our existing knowledge is very recent. We can recognise them on sight, but we would be safe in saying that that is the sum of our knowledge in well over nine-tenths of the cases. We know little of their distribution or the causes governing this, and practically nothing about how they affect the host. In under 5 per cent. of the cases, do we know even the outline of the life cycle. We have only the most superficial knowledge of therapeutic measures—only two outstanding drugs have been introduced into veterinary helminthology in modern times—carbon tetrachloride and tetrachlorethylene. Practically all the others in every day use are heritages of ancient civilisations. Research is too often uncontrolled and the workers are too few to make other than slow progress. Little help is given by the pathologist—the technique for examining for helminths is too little understood and even trained pathologists only see the grosser forms—and most species are minute. But even with our present knowledge much could be done to reduce losses in stock—if only the stock owner would co-operate. It is impossible in a paper of this length to detail prophylactic measures for individual cases; but perhaps I may be permitted to deal collectively with the main lines on which this can be carried out.

GENERAL PRINCIPLES OF PREVENTION.

1. Destruction of adult worms *in situ*. This must be regarded as a preventive measure as well as a curative one and it is in the former light that we shall discuss it. All anthelmintics are animal poisons. And accordingly should only be given under expert advice. Flocks and herds should be treated in the mass in order to abolish the reservoirs from which other animals are being infected. This is specially true for older animals which generally do not show symptoms of parasitism so much as young animals. We know few satisfactory anthelmintic drugs; but these should be used wherever possible. This is specially true for sheep where a mixed infection in the abomasum and intestine is the rule. Most drugs are satisfactory for only some species; but a reduction in number of even only one species will lessen the strain on the host and reduce the potentialities for infection. Any drug which produces a mild transient enteritis, for example, will remove intestinal worms; and bacteria often play a natural role in doing this. Monthly treatment of

sheep and horses will very considerably lessen infection and keep the animals in good condition.

2. Manure disposal if perfect, would eliminate the vast majority of helminths. Unfortunately it is far from perfect. In special circumstances it can be stored until its own heat has destroyed the eggs which it contains ; or it can be burned ; or it can be spread on fields which are used either for crops or, if for pasture, where other kinds of stock will graze. The helminths of different animal groups, as a rule, are not interchangeable. Young animals, especially should be kept off fields where manure from their own species or from human or canine sources is used. Chemical disinfection of manure is not yet practicable.

3. Once the eggs are hatched, it is more difficult to keep them away from the animals. Most of the forms in this country must be swallowed with food or water. Many larvæ climb up grass in damp weather, retreating to the soil when the sun dries the grass. Housing animals until the dew is off the grass, draining of pastures, burning of long grass—are all possible, if not always practicable, methods of control. The use of raised water troughs is a useful measure when the larvæ—as in the case of the husk-worms—are mainly water-carried. Mixed grazing kills many. In a mixture of sheep and horses, for example, many of the sheep larval forms are eaten and digested by the horses and *vice versa*. The feeding of animals on bare ground or in stables is often valuable and rotation of pastures and stock also helps. Permanent pastures are always dangerous.

4. When the larva enters the host, control becomes even more difficult, but some success has been obtained by the use of " licks " containing tobacco and other substances which are lethal to the young worms. Repeated dosing with anthelmintics is, however, the only practicable method at our command at present.

5. When an intermediate host is necessary, control must be centred on its elimination. Snail control is relatively easy, in theory at least, since the use of copper sulphate has become common. The aeroplane has even been pressed into service in spreading this chemical. Ecto-parasite and other branches of insect control are subjects which necessitate the attention of all interested in worms as well as entomologists, but it is too large a subject to discuss here.

6. Reservoirs. Many of the helminths of domesticated animals are also found in wild mammals and much more information as to the parasitic fauna of the wild animals of all countries is necessary. Syngamus in wild birds, liver-fluke in rabbits and deer, Echinococcus in foxes and so on are examples from this country. Accordingly no parasitic survey of a district can afford to neglect wild hosts, and preventive measures must take cognisance of their presence.

So much for the present. The situation is serious and is yearly becoming more serious. What of the future ? More and better research is urgently required. But helminthologists can not be made overnight and the process of interesting and training suitable men must be carefully carried out. Parasitology is not a narrow field of study—it is as wide and general as biology itself ; and no zoologist can pass through his professional life without over and over again meeting parasitic helminths. Helminthology must postulate a general zoological training ; but as a rule, the young student gets an introduction to parasitology in his early zoological classes which effectively puts him off the subject for the remainder of his professional life. The subject is usually inaccurately taught and uninterestingly presented, and the few exceptions serve merely to emphasise this. It is almost always entirely anthropomorphic in its outlook, and unsuitable or aberrant types are chosen either because it is believed that students will become interested only in the parasitic worms because they occur in man or because tradition has selected the types. Neither reason seems to me to be valid. The subject should be taught practically and, as Professor Leiper has repeatedly pointed out, the student can collect parasites from his own dissection animals. He can find suitable trematodes in his frogs, suitable tapeworms in his rats and mice, suitable nematodes in his rabbits. His interest is immediately aroused by forms which he himself has collected and he realises that parasitism is one of the commonest phenomena in nature. It will be argued that the bulk of the students in the early zoological classes are destined to become medical men and that therefore medical types should be chosen. This reason is no more valid than the others. The botanist does not teach bacteriology ; and helminthology, as a branch of medicine, should not be introduced into the curriculum until the student has studied disease. The experience of teachers in post graduate medical classes is that the ignorance of this subject displayed by the young graduate is colossal, and that the time

spent on helminthology in his first year, has been entirely wasted. The position in veterinary medicine is much better, as helminthology is taught as a special subject late in the professional curriculum. I submit that zoologists are largely missing their opportunity, that helminthology should be introduced into the zoological curriculum only as an introduction to a group largely responsible for the phenomenon of parasitism, with generalised, simple, typical " types," and that, as a branch of pathology, it should be introduced much later into the medical curriculum. Thus treated, the subject would not only be better taught, but would actually excite the interest of the student. Once his interest is excited, it becomes necessary to discuss the subsequent qualifications desirable for the man who will be encouraged to undertake helminthological research. This research may of course, follow several different avenues of approach ; and which we should adopt will largely depend on the type of man we are dealing with. There appear to be three main avenues—apart of course from the use of helminths purely as zoological material, for cytology, embryology, experimental biology and so on. Applied helminthology seems to demand one or more of the following three qualifications :

1. *Zoological.*—We must be able to recognise our animals when we see them ; *i.e.*, we must know taxonomy and morphology. We must know their life cycles in the free state or in the intermediate host and we must be able to recognise the stages. We must know how worms live, what products they secrete or excrete, how they feed, breed, and so on. These are all questions of pure zoology and a general zoological and biochemical training is necessary for the man who undertakes research along these lines.

2. *Medical and Veterinary.*—We must know what a helminth does to an animal, how it affects the animal organism by its habitat, its search for food, its larval and adult migrations, how it disposes of its metabolic products and disperses its eggs or larvae, and how it can be eliminated. These are problems of pathology and therapeutics which can only successfully be tackled by one with a medical or veterinary training, with his knowledge of comparative pathology, bacteriology and biochemistry.

3. *Agricultural.*—We must know how to prevent infection in our stock, how agricultural practice hinders or prevents infection, how preventive measures can be formulated so as not to conflict too much with established practice or to destroy valuable by-products. This is a most

important line of research where an agricultural training is essential with a knowledge of zootechny, breeding and feeding habits of stock and general farm management.

Each worker must know at least a little of the other branches and no real hard and fast line can be drawn between the various kinds of research. Veterinary helminthology cannot be restricted to a knowledge of the worms of domesticated animals alone : it must include those of man and of the related wild animals at least and, ideally, would include all parasites of all animals. Each class of worker must know his literature and this has been simplified in recent years by the work of Stiles and Hassall in America and the I.B.A.P. in Britain. The young worker will find that he must have more than the patience of Jacob before he can obtain his Rachel. He will have to live in the shadow of the slaughter house and the manure pile and work often under most uncomfortable conditions, and he must do it because he wants to do it. In this however, as in most other research careers, success depends less on ability than on adaptability.

I hope I have not painted too dark a picture both of the present and the future. There are many at present who amply comply with the requirements which I have laid down. But many more are necessary before progress will be obvious. They must come forward of their own free will however, not as the result of financial baits held out by research institutes : their aim must be to make a life rather than a living.

I have tried to answer in general lines three questions : how serious are helminthic infections in stock ; what we can do with our present knowledge ; and how we should go about to increase that knowledge. There is no doubt that helminthiasis is a most serious menace to the health of the stock animials of this and other countries—at least as serious as the bacterial and virus diseases. We have disturbed the balance of nature and we are only just beginning to realise that we cannot do this with impunity. This disturbance is still continuing and strenuous and intensive work will be constantly required both in the laboratory and the field before we can regard the situation with anything approaching satisfaction.

GENERAL METHODS OF PREVENTION.

1. DESTRUCTION OF ADULT WORM *IN SITU*.

Anthelmintics.
Bacterial diseases.

2. DESTRUCTION OF RESERVOIRS.

Dogs.
Rabbits.
Wild Game.

3. MANURE DISPOSAL.

Chemicals, e.g. Lime.
Heat.
Storage.
Selective disposal.

4. DESTRUCTION OF LARVÆ.

Disinfection by heat or chemicals.
Burning of grass.
Drainage.
Mixed grazing.

5. PREVENTION OF INGRESS.

Bare lots.
Raised troughs.
Stables.
Pasture rotation.
Stock rotation.
Fencing.
Night housing.
Preventive licks.

6. DESTRUCTION OF VECTORS.

Snail control.
Fly control.
Beetle control.

7. GENERAL PRECAUTIONS.

Avoid overstocking.
Avoid permanent pastures.
Keep young on dry land.
Do not mix young and old stock.
Encourage mixed grazing.
Keep buildings clean.
Quarantine introduced stock.

SPECIAL APPLICATIONS.

LIVER-FLUKE CONTROL.

a ADULT.
Dose sheep.
Kill wild reservoirs.

b EGG.
Keep sheep from dangerous land.
Confine at nights.

c SNAIL.
Dain land.
Use Copper sulphate and lime.
Protect snail-eating birds.

d CERCARIA.
Keep drains clean.
Avoid infected ground.
Fence dangerous patches.

ASCARIS CONTROL IN PIGS.

a Dose sow before farrowing.
b Clean farrowing pen and sow.
c Keep litter away from infection.

HÆMONCHUS CONTROL.

a Dose flocks monthly.
b Use bare lots and raised troughs.
c Confine lambs morning and night.
d Put lambs on safe ground.
e Rotate pastures.
f Mix stock.
g Lamb early.

SCLEROSTOME CONTROL.

a Dose adult horses frequently.
b Store manure in heat-producing boxes.
c Mix grazing stock.
d Clean stables.
e Keep foals off infected fields.

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